THE ARTE OF DIALING:

SHEWING,

Hovv to make any kind of Diall vpon a plaine ſuperficies howſoeuer placed.

[*.*]

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A TREATISE OF DIALLING

CAP. I.

The making of the Clinatory.

1 DIals are diuerſly made according as they are diuerſly placed. Therefore their ſituation muſt firſt be knowne: which may be done by an inſtrument not vnfitly called a Clinatory.

2 Let this inſtrument be made iuſt foure ſquare, and let the thickneſſe bee about halfe a quarter of the breadth of it, vpon one ſide thereof deſcribe a quadrant, whoſe two ſemidiameters or ſides muſt be paralel to the ſide of the quadrate.

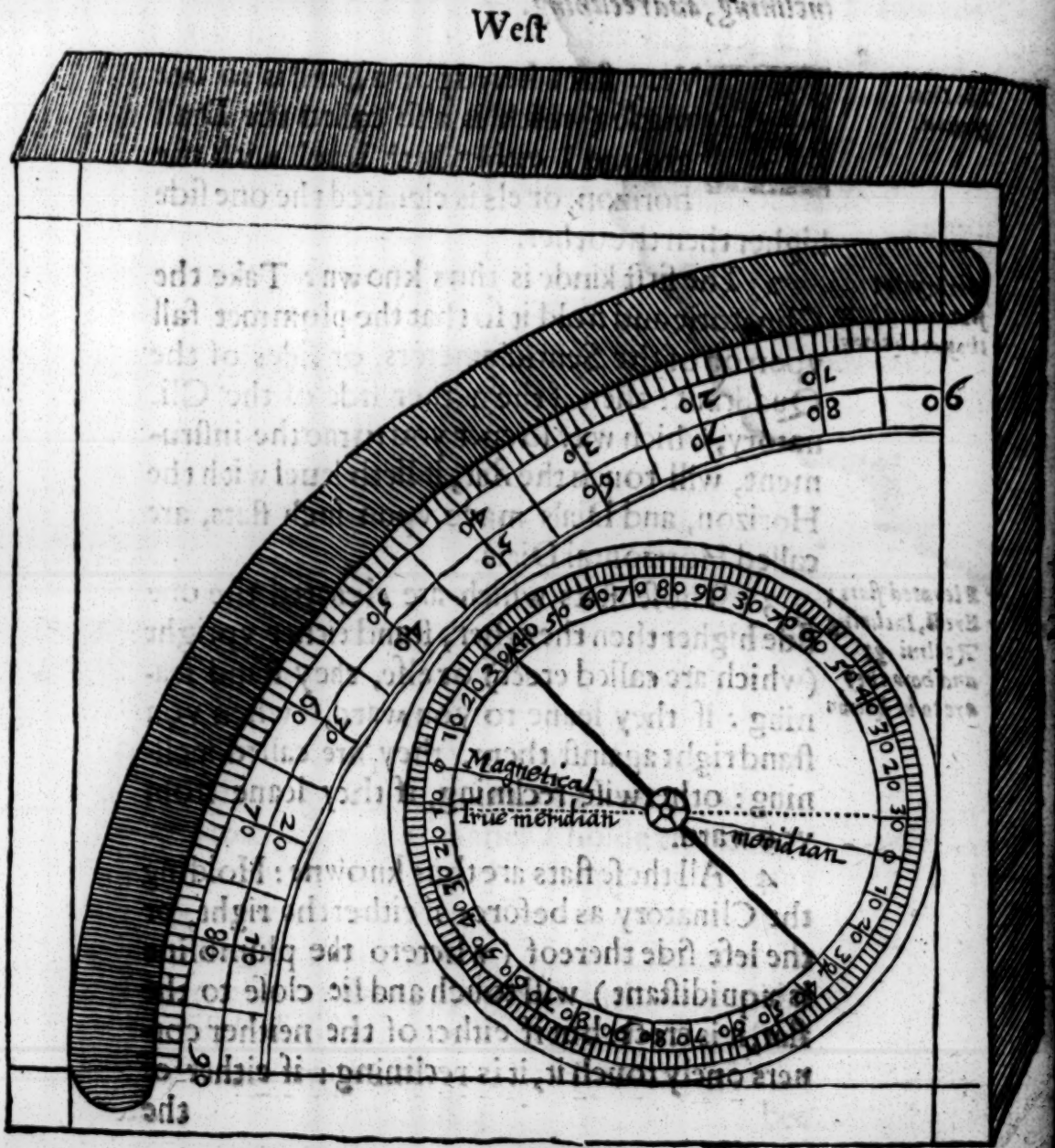
3 The quadrant muſt bee diuided into 90. degrees, with figures ſet to euery fifth or tenth degree (as the manner is) both forward and backward, and without the peripherie thereof, a groofe or furrowe muſt be made ſo deepe that

a plummet hanging by a thrid from the Center of the quadrant may fall into it, in such sort that the thrid may come close to the degrees of the quadrant.

4 Close within the limb of this quadrant make a great round hole or box, for the placing of a magneticall needle within the same, whose true Meridian line must bee perpendicular to one of the sides of the quadrant, which shall be called the North side, and the other side of the quadrant shall bee called the East-side, to the which the Westside of the Clinatory is opposite, as the South side of the Clinatorie is opposite to the Northside of the quadrant: and the magneticall Meridian, must bee drawne in the bottome of the box according to the variation of the place where you are.

The

The figure of the Clinatory.



CAP. II.

The first diuision of Dials into Horizontall, erect inclining, and reclining.

The Dial ground.

EVery flat whereupon a Diall is to bee made (which is also called the Diall ground) either lieth leuel with the horizon, or els is eleuated the one side higher then the other.

Horizontal flats: and how they are known.

2 The first kinde is thus known: Take the Clinatorie and hold it so that the plummet fall vpon on of the Semidiameters, or sides of the Quadrant: then if the nether side of the Clinatory, which way so euer you turne the instrument, will touch the flat, it lieth leuel with the Horizon, and Dials made vpon such flats, are called Horizontal Dials.

Eleuated flats; Erect, Inclining Reclining: and how they are to be known

3 Those flats which are elevated the one side higher then the other, stand either vpright (which are called erect) or else, they stand leaning: if they leane to you ward, when you stand right against them, they are called inclining: otherwise reclining, if they leane from you ward.

4 All these flats are thus knowne: Holding the Clinatory as before; if either the right, or the left side thereof (whereto the plumbline is æquidistant) will touch and lie close to the flat, it is erect: but if either of the neither corners onely touch it, it is reclining: if either of the

the vpper corners onely touch it, it is inclining.

5 And how much the reclination or inclination is, you shall know after this manner.

6 Set one of the sides of the Clinatory to the flat, in such sort, that the plumbline hanging at liberty, may fall vpon the circumference of the quadrant: for then the arke of the quadrant, betwixt the plumbline and that side of the quadrant that is parallell, or æquidistant to the flatte, is the reclination thereof, if the center of the quadrant be from the flat, or else the inclination, if it bee towards the same. *To know how much the reclination or inclination is.*

Cap. III.

The second diuision of Dials into direct and declining.

ALl flats are either direct, or declining.

2 All flats lying leuel with the Horizon are direct.

3 But if the flat lie not leuel with the Horizon: you shall thus know whether it be direct or declining. First, draw therein a line parallel to the Horizon, after this manner: holde the Clinatory to the flat in such sort, that the plumbline may fall vpon one of the sides of the quadrant; then draw a line by the nether side of the Clinatory in recliners; or by the vpper side in inclliners, or by either of those sides in erect flats, for that line shall be parallel or æquidistant to the Horizon, and may

be called the Horizontall line. Set the North side of the Climatorie to this liue, if the North end of the needle looke towards the flat: then if the Magnetical Meridian be right vnder the needle, it is a direct flat: but if it differ from it, it is declining, and that so much as that difference is, and that way which the North end of the needle declineth from the Northend of the Meridian line in the climatory.

4 If the Southend of the needle looke towards the flat, made your account contrarywise.

CHAP. IV.

The third diuision of Dials, either agreeing with the plaine of the Meridian, or disagreeing from the same.

ALl flats doe either agree with the plaine of the Meridian circle (which may therefore bee called meridian flats) or else they disagree from the same.

2 They are knowne thus: If the flat bee erect and declining 90. degrees, it is a Meridian flat, otherwise it is no Meridian flat; and then you must first draw therin the meridian line, after this maner.

How to drawe the Meridian line, in Horizontall flats.

3 If the flat be Horizontal, take the climatory and lay it flat downe thereupon; and turning it about till the needle hang precisely ouer the Magneticall meridian, by that side thereof that is parallel to the true Meridian line of the Climatory, drawe a right line, for that shal be the Meridian line desired.

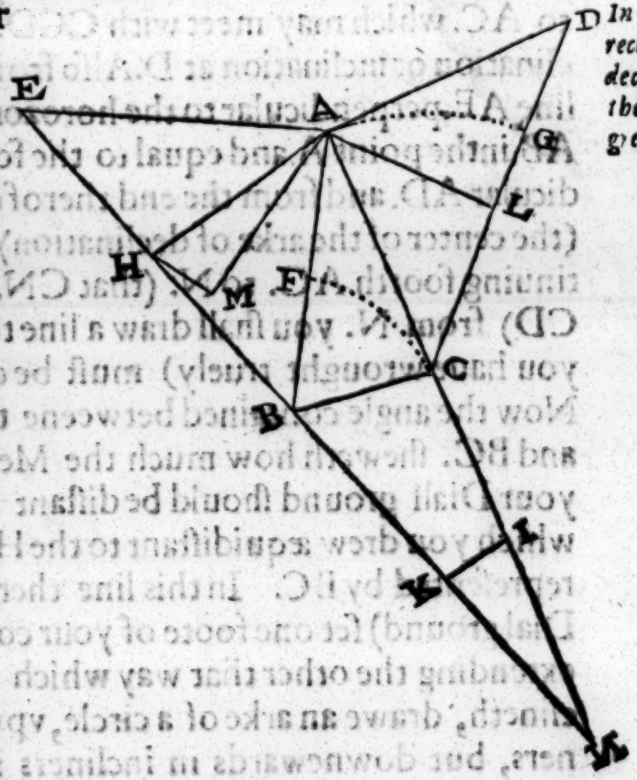
4 In erect flats the Meridian line is perpendicular, and therefore laying the Climatory close to such

such a flat in such sort that the plumbline hang precisely on either side of the quadrant, a line drawne by the side of the clinatory, parallel to that side of the quadrant, shall be the meridian line. *In erect flats.*

5 In direct flats, a line perpendicular to the line æquidistant from the Horizon, is the Meridian line we seeke for. *In direct flats.*

6 In flats reclining or inclining, declining also 90. degrees (which are commonly called, East, or West reclining or inclining) the meridian line is parallel to the horizon. *In reclining or inclining flats, declining 90. degrees.*

7 For a lother inclining or reclining, & withall declining flats, drawe a line vpon some pastbord or paper which shall bee called the horizontal meridian A B, wherein settingone foot of your cõpasses, with the other draw an arch of a circle; & therin reckon the complement of the declination *In incl ning or reclining flats declining lesse then 90. degrees.*

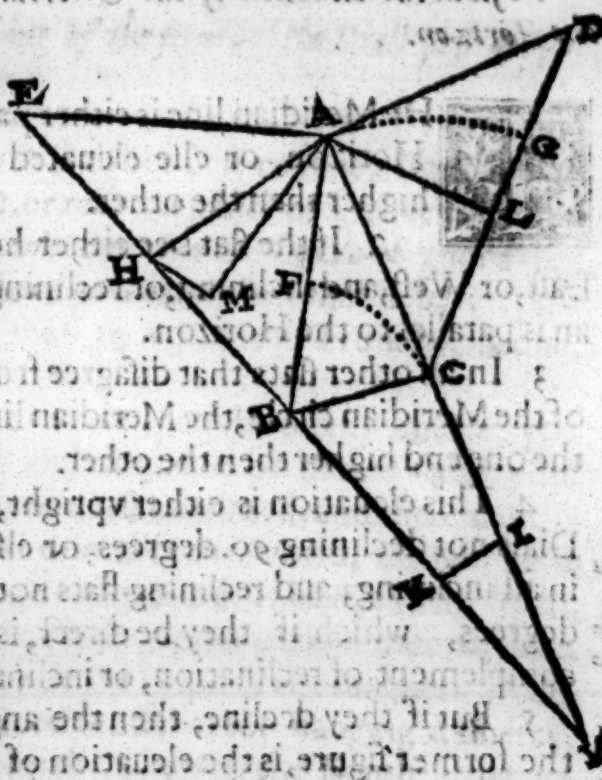


declination FC. drawing a right line BC. by the end thereof out of the center B. This right line you ſhall croſſe ſquire-wiſe with another as AC. which may be called the baſe of inclination or reclination, and muſt alſo meet with the horizontall meridian at A. and ſetting one foot of your compaſſes in the croſſing at C. with the other foote draw an arke, counting therein the complement of the reclination or inclination AG. drawing a right line by the end therof, out of the center of the foreſaid ark CGD. & from A erect AD. perpendicular to AC. which may meet with CGD. the line of reclination or inclination at D. Alſo from A. draw the line AE. perpendicular to the horozontal meridian, AB. in the point A. and equal to the former perpendicular AD. and from the end therof draw a line to (the center of the arke of declination) B. Then continuing foorth AC. to N. (that CN. be equall to CD) from N. you ſhall draw a line to B. which (if you haue wrought truely) muſt be equall to BE. Now the angle contained betweene the lines NB. and BC. ſheweth how much the Meridian line in your Diall ground ſhould be diſtant from the line which you drew æquidiſtant to the Horizon heere repreſented by BC. In this line therefore (in the Dial ground) ſet one foote of your compaſſes, and extending the other that way which the Diall declineth, drawe an arke of a circle, vpwards in recliners, but downewards in incliners: and therein count the ſaid angle from the line parallel to the Horizon, and drawe by the end thereof a line,

which

which shall bee the true Meridian in the Dial ground.

8 From A draw AH perpendicular to E B. make BI. equal to BH. from I. let IK be drawn perpendicular to BN. make CL. equal to CK and draw a line from L. to A. of these three lines A H. IK and L A. make the triangle AHM. for then the angle AHM. is the angle which the dial ground maketh with the plain of the meridian.



To finde the angle which the dial ground (or flat) maketh with the plaine of the meridian.

CHAP. V.

To finde the eleuation of the Meridian line aboue the Horizon.

How to finde the eleuation of the meridian line.

THe Meridian line is either parallel to the Horizon, or elſe eleuated the one end higher then the other.

2 If the flat bee either horizontal, or Eaſt, or Weſt, and inclining, or reclining, the meridian is parallel to the Horizon.

3 In all other flats that diſagree from the plaine of the Meridian circle, the Meridian line is eleuated the one end higher then the other.

The eleuation of the meridian line in erect dials. In reclining or inclining direct flats; in reclining or inclining declining flats.

4 This eleuation is either vpright, as in all erect Dials not declining 90. degrees, or elſe leaning, as in all inclining, and reclining flats not declining 90 degrees, which if they be direct, is equall to the complement of reclination, or inclination.

5 But if they decline, then the angle ABE. in the former figure, is the eleuation of the Meridian line.

The eleuation of the meridian whether North or South.

6 If the meridian line bee not erect, it leaueth either Northwards, when the eleuated end thereof looketh towards the North, or elſe Southwards when the eleuated end looketh towards the South.

Flats polar.

7 All flats are either Polar (which being continued would goe by the poles of the world) as all leaning flats, wherein the eleuation of the meridian line is Northwards, and equall to the poles eleuation: and all erect decliners 90. degrees. Otherwiſe they are no polar flats.

Not polar.

Chap. VI.

The describing of the figure of the Diall first on paper or pasteboard.

NOw it shall bee best to take a sheet of paper, or rather a pastebord, that you may therein describe the figure of your Dial, before you draw the Diall it selfe vpon his ground; that is, vpon the Truncke, Stone, wall, &c.

2 This paper, or pasteboord therefore, you shall place, or vnderstand to be placed so as your Dial ground is or must be placed, and therein write the names of the parts of the world, as they lie in respect of your Dial ground, as East, West, North, South, Zenith, Nadir, vpper part, nether part, &c. which you may do by helpe of the magnetical needle: for the North end thereof (hanging at liberty) sheweth the North, whereto the South is diametrally opposite; and your face being turned towards the North, your right hand sheweth the East, your left hand the West, the Zenith, or verticall point is aboue your head, the Nadir vnder your feete. Note also, which end of the Meridian line must be higher, and which lower; if the Meridian be not parallel to the Horizon.

CHAP. VII.

The making of Æquinoctiall Dials.

ALl Diall grounds are æquinoctiall, or not æquinoctiall.

2 An æquinoctiall ground is that which agreeth euen with the plaine of the æquinoctiall Circle: which is thus knowne. If the Diall ground be direct, and the Meridian line eleuated Southwards, equally to the complement of the poles eleuation, it is an Equinoctiall Diall ground, otherwise not.

3 In an Equinoctial Dial you shall describe the houre lines after this manner.

How to make Equinoctial Dials.

4 Set one foot of your Compasses in the Meridian line AB. and with the other, drawe a circle DBC. and deuide it into 24. equall parts, as D.E. F.G. &c. beginning at B. the crossing therof, with the Meridian line; for then right lines, as AD. AE. AF. AG. &c. in the 1. and 2. figure drawne out of the Center, by those diuisions shall bee the houre lines.

Placing of the stile.

5 The stile must stand vpright out of the center of the Diall.

6 Of Equinoctiall Dials there be two sorts, the vpper and the nether.

Vpper Equinoctial dial.

7 The vpper Equinoctial Dial looketh vpwards to the eleuated Pole of the world: And it sheweth the houre of the day, onely in the Spring and Summer time, as in the first figure.

8 The

8 The nether, or lower Equinoctial dial, is that which looketh downewards to that Pole of the world which is beneath the Horizon; and sheweth the houres onely in Autumne, and Winter, as in the second figure. *Nether Equinoctial dial.*

Chap. VIII.

The finding of the substilar line, and stile, in grounds not Equinoctiall direct, and Polar.

IN all Dial grounds that are not Equinoctiall, the substilar line, and the distance of the stile from the substilar must bee found.

2 The substilar line is that, right ouer which the stile must be set. *Substilar line.*

3 The distance of the stile from the substilar, is the angle, or space contained betweene the stile, and the substilar line. *Distance of the stile from the substilar.*

4 The finding out of these is diuers, in diuers kinds, and therefore must bee specially shewed in each kinde. *The finding of the substilar line.*

5 In direct Dial grounds not Equinoctiall, and Polars not Meridian, the substilar line is the same with the Meridian line, or else parallel thereto, in declining polars. *In direct flats not æquinoctiall In Polars not Meridian.*

6 In Polar ground, agreeing with the plaine of the Meridian, the substilar line may thus be found. *In Meridian Polars.*

7 Set one foot of the compasses in the South-end of the line that you drawe equidistant from the Horizon and extending the other foot towards the

North end of the ſame line, draw an arke of a circle: therein reckon the eleuation of the Pole beginning at the foreſaid line: for a right line drawne thereby out of the center, ſhall be the ſubſtilar line AB. figure. 3.

The ſtilar line in all Polar Dials.

8 In al Polar grounds draw a parallel CD. (figu. 3.4.5.6.7.8.) to the ſubſtilar line at a conuenient diſtance from the ſame; for that ſhall be the line repreſenting the ſtile.

CHAP. IX.

The finding of the diſtance of the ſtile from the Meridian line in Dials that be neither equinoctial nor polar.

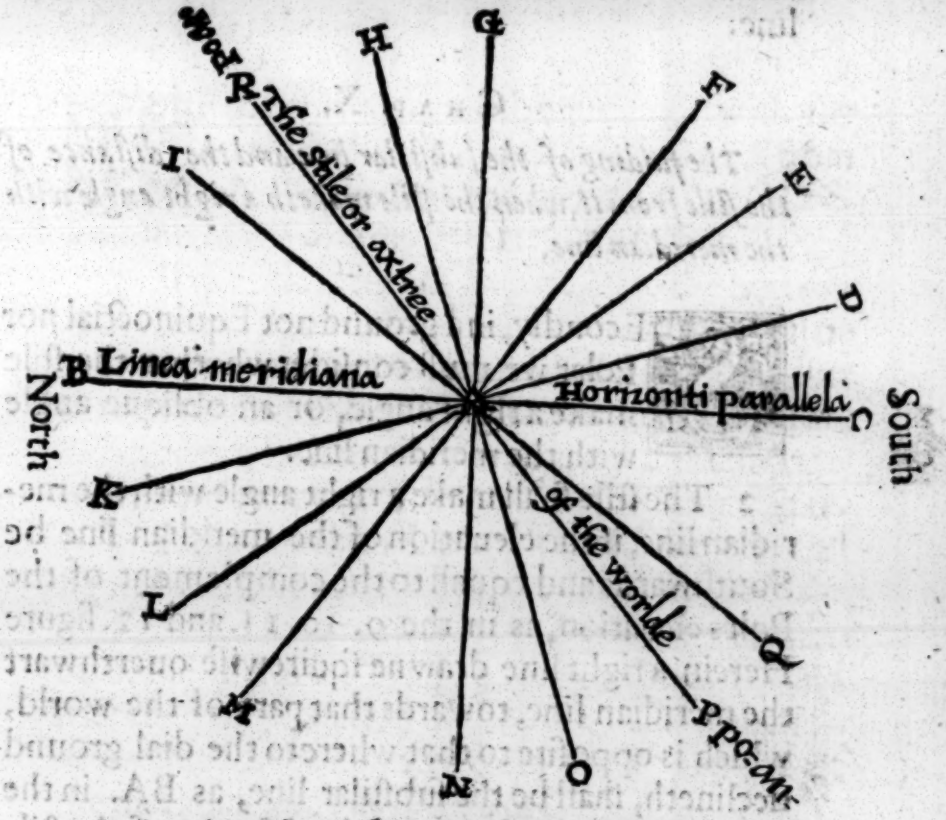
IN all Dial grounds that be not æquinoctiall nor polar, before the ſubſtilar line, and diſtance of the ſtile from it can be found, firſt the diſtance of the ſtile from the Meridian line muſt be found after this maner.

2 If the Meridian line be parallel to the Horizon, as BC. the diſtance of the ſtile from the Meridian line, is equal to the height of the Pole, as BR.

3 But if the eleuation of the Meridian be either vpright, as AG. or leaning towards the North, and withall greater then the Poles eleuation, as AH. the height of the Pole BR. taken out of the height of the Meridian line BH. or BG. ſhal leaue the diſtance of the ſtile from the Meridian line RH. or RG.

4 If the eleuation of the meridian line be Northwards, and leſſe then the height of the Pole, as BI. take

take the eleuation of the meridian line B I. out of the height of the pole B R. and there ſhall remaine the diſtance of the ſtile from the Meridian line R I.



5 If the eleuation of the Meridian line be Southwards, and either greater, or equal to the complement of the Poles eleuation, as AF. and AE. then the complement of the Meridian lines eleuation, FG. or EG. added to the complement of the Poles eleuation GR. ſhall make the diſtance of the ſtile from the meridian line.

6 If the eleuation of the meridian line be Southward and leſſe then the complement of the poles eleuati-

tion as CD. the elevation of the meridian line CD and the height of the Pole CP. put together shall make the distance of the stile from the meridian line.

CHAP. X.

The finding of the substilar line and the distance of the stile from it, when the stile maketh a right angle with the meridian line.

SEcondly, in a ground not Equinoctial nor Polar we must consider whether the stile make a right angle, or an oblique angle with the meridian line.

2 The stile shall make a right angle with the meridian line, if the elevation of the meridian line be Southwards and equall to the complement of the Poles elevation, as in the 9. 10. 11. and 12. figure Herein a right line drawne squirewise ouerthwart the meridian line, towards that part of the world, which is opposite to that whereto the dial ground declineth, shall be the substilar line, as BA. in the 9. 10. 11. and 12. figu. and the distance of the stile from the substilar line shal bee equall to the angle which the dial ground maketh with the plaine of the meridian circle as the angle BAD. fig. 9. 10. 11. 12. which angle is found by the third Chap.

CHAP.

Chap. XI.

From which end of the Meridian line, the eleuation of the ſtile is to be counted.

IF the ſtile make an oblique angle with the meridian line, we muſt firſt finde out from whether end of the meridian line, the eleuation of the ſtile muſt be reckoned, thus:

2 If the meridian line be parallel to the horizon as in the 13. figure, the eleuation of the ſtile ſhal be reckoned from the North end of the meridian line in reclining, and horizontal flats looking vpwards, as BR. from B in the former figure, but contrariwiſe in incliners as PC. from C. in the ſame figure.

3 If the meridian line be eleuated the one end higher then the other from the horizon, and the dial ground looke towards the South, the eleuation of the meridian being alſo Northwards, and leſſe then the eleuation of the pole: the eleuation of the ſtile ſhal be counted from the vpper end of the meridian line: as IR. from I.

4 But if the eleuation of the meridian be greater then the eleuation of the pole, or vpright, or ſouthwards and greater then the complement of the poles eleuation; the eleuation of the ſtile ſhall bee counted from the neather end of the meridian line, as PM, PN, PO, from MNO.

5 If the eleuation of the meridian line be Southwards and leſſe then the complement of the poles eleuation, the eleuation of the ſtile ſhal be counted

from the vpper ende of the meridian line as DP. from D.

6 If the Dial ground looke toward the North, the eleuation of the ſtile from the meridian line ſhal be reckoned contrariwiſe in euery kinde.

CHAP. XII.

The finding of the ſubſtilar line and ſtile in Dials that be not Polar nor Equinoctiall, The ſtile making oblique angles with the Meridian line.

HAuing thus found out from whether end of the meridian line the eleuation of the ſtile is to be reckoned, ſet one foot of your compaſſes in the meridian line as in A. and ſtretching foorth the other foot towards that end of the meridian line, from which the eleuation of the ſtile is to bee reckned as towards L. draw an arch of a circle MDLN. and (beginning at the Meridian line) reckon and marke therein the eleuation of the ſtile from the Meridian line, LD. figure 13. 14. 15. in the reſt LO. either Eaſtwards or Weſtwards in direct Dials, as in the 13. 14. 15. fig. but in decliners towards that part of the world which is oppoſite to the part whereunto the Dial declineth, as in the 16. 17. 18. fig.

2 Then in direct Dials, a right line ACD. fig. 13. 14. 15. drawne out of the center of the ſaid arke by the marke of the ſtiles eleuation from the meridian line ſhall be the line repreſenting the ſtile, and

therefore

therefore the diſtance of the ſtile from the ſubſtilar line ſhall be the diſtance of the ſtile, from the meridian line.

3 But in decliners you ſhall thus finde the ſubſtilar line: From O the point of the ſtiles eleuation from the meridian line in the foreſaid arke drawe OP. a perpendicular to the meridian line AL. and taking the length of this perpendicular with your compaſſes, leaue one foote in P. the concurſe therof with the meridian line, and with the other deſcribe a quadrant of a circle QRO. beginning from the Meridian line, and ſo proceeding vnto O the other end of the perpendicular line; and in that quadrant beginning at the meridian ALQ. reckon and marke QR. the complement of the angle conteined betweene the plaines of the diall ground and of the meridian circle, and take with your compaſſes RS. the diſtance of that marke from the meridian line, and ſetting one foote of the compaſſes in P. the meeting of that perpendicular with the meridian line, with the other make a prick T, in the ſame perpendicular line: for then AB. a right line drawn by this prick T. out of the center of the foreſaid arke MDLN. ſhall bee the ſubſtilar line.

4 Then take with your compaſſes TR. the diſtance of the foreſaid marke in the quadrant, QRO. and this pricke, and leauing one foote of your compaſſes in the ſame pricke T. with the other make another pricke V. in the arke you firſt deſcribed; for then a right line AV. drawne thereby out of the

arch you firſt deſcribed ſhall bee the ſtilar line, or line repreſenting the ſtile.

5 In Dials not polar nor æquinoctiall, if the diſtance of the ſtile from the ſubſtilar line be but ſmal as in the fig. 10. 12. 17. it may bee increaſed by drawinga paralel CD. to the ſtile already found, which for diſtinctions ſake may bee called, the ſtile augmented.

The ſtile augmented.

CHAP. XIII.

The drawing of the line of Contingence, and of the Equinoctiall circle, and how it muſt be diuided.

NOw in all Dials that be not æquinoctiall, draw a right line, EHF. ſo long as you can, making right angles with the ſubſtilar line, which is called the line of contingence, or touch line.

2 Then deſcribe the Equinoctiall circle GHI. after this manner. Take with your compaſſes the ſhorteſt diſtance betweene H. the interſection of the line of contingence with the ſubſtilar line, and the ſtilar line, and leauing one foot in that interſection, with the other make a pricke B. in the ſubſtilar line, whereupon deſcribe a circle GHI. which ſhall be called the equinoctiall circle.

3 If the diſtance of the ſtile from the ſubſtilar be augmented, you muſt draw two touch lines and two æquinoctial circles: as in 10. 12. 17. figures.

4 The halfe of the æquinoctiall circle next the line

line of contingence must be deuided into 12. equal parts, beginning at H, the interſection thereof with the ſubſtilar line in all direct dials, and erect or meridian polars which are commonly called East or West dials erect, as in the 3.4.5.6, 13.14.15. figures.

5 In polars not meridian nor direct, let HK, in fig. 7. & 8. (the complement of the angle which the dial ground maketh with the plaine of the meridian) be numbred and marked in the æquinoctial circle, beginning at the ſubſtilar line, and proceeding that way which the diall ground declineth as from H. to K. for at that marke K you muſt begin to diuide.

6 In decliners not polars, if the ſtile make a right angle with the meridian line, as in the 9.10 11.12. figu. a paralel to the line of contingence, drawne by the center of the æquinoctiall, ſhall ſhew the beginning of the diuiſion, as BK in figu. 9.10.11.12.

7 But if the ſtile make an oblique angle with the meridian line, and the line of contingencye, cut the meridian line, as in the 16. figu. your ruler laid to that cutting at X and the center of the Equinoctial B. ſhal ſhew in the peripherie thereof, the beginof the diuiſion K if the diſtance of the ſtile from the ſubſtilar be not augmented.

8 But if it be augmented (as in the 17. figure) the ſhorteſt diſtance HX betweene H the interſection of the touch line, with the ſubſtilar line, and the ſtile not augmented AV muſt bee taken with the compaſſes, and reſting one foot in that interſection H, with the other make a pricke Y in the

ſubſtilar line, towards B the center of the Equinoctiall; by which pricke Y & Z the mutuall interſectiō of the next touch line with the meridian line, let a right line YZ be drawne, for BK. and BK paralels to it drawne out of the centers of both the Equinoctials, towards the meridian line, at their croſſings with the Equinoctials K & K ſhall ſhew the beginnings of their diuiſions.

9 But if the touch line cut not the meridian line as in the figure 18. let a paralel thereto XY bee drawne, which may cut the meridian line in Y and take with the compaſſes the ſhorteſt diſtance ZA betwixt the interſection thereof with the ſubſtilar line and the ſtile not augmented; and leauing one foote in that interſection Z, with the other make a pricke B in the ſubſtilar line towards the center of the Equinoctiall; from this pricke drawe a right line BY from B to Y the interſection of the ſaid paralel with the meridian line; for BKA paralel to this line drawne out of the center of the Equinoctiall B. ſhall ſhew the beginning of the diuiſion K.

CHAP.

Chap. XIIII.

The drawing of the houre lines in all Dials that bee not Equinoctiall.

HAuing thus, deuided the Equinoctial circle, lay your ruler to the center thereof B. and to euery one of those prickes ϛ.ζ.η.θ.ι.κ.λ.μ.ν. by which it is deuided, and make marks ξ.ο.π.ρ.σ.τ.υ.φ.χ.ψ.ω. &c. in euery place where it crosseth the line of contingence for then

2 In all polar Dials paralels to the substilar line, drawne by those markes, shall bee the houre lines, as in the 3. 4. 6. 7. 8. figu.

3 In Dials not polar, in which the height of the stile is not augmented, right lines drawne out of the center of the dial by those markes shal be the houre lines as in the 9. 11. 13. 14. 15. 16. 18. figu. And if any of the diuisions of the æquinoctiall circle doe fall in to the substilar line, a paralel to the line of contingence drawne by the center of the said diall, shall shew two opposit houres, distant by the space of six houres from the substilar line; as for example in direct Dials, six in the forenoone and six in the afternoone, as in the 13. 14. 15. figure. Also if the ruler laid to B. the center of the Equinoctial circle, and some diuision thereof, as V in the 16. and 18. figu. cannot crosse the line of contingence, and yet draweth neerer to it, : draw BY. a right line from the center of the Equinoctial by that diuision, and draw AF a paralel to that line,

which

which may crosse the substilar and line of contingency in F. then let H A. the other part of the substilar that is betweene the line of contingence and the center of the dial A. be cut in such sort that the segments, of the substilar line concurring at the line of contingence AH and HB. may keepe the same proportion which the greater segments B H. and HA. haue, which are contained betweene the center of the Dial and line of contingence, and betwixt the center of the Equinoctiall and the line of contingence. And let a right line BF. bee drawne by that section B and the section of the line of contingence F. For AI a paralel to this right line drawne out of the center of the Diall shall be the houre line that wee seeke for.

4 In those dials wherein the distance of the stile from the substilar is augmented, right lines drawne by those markes in both lines of contingence which are proportionately distant from the substilar line shall be the houre lines.

CHAP.

Chap. XV.

What number muſt be ſet to the houre lines.

IN meridian Dials, the ſubſtilar line is the line of the ſixth houre: but for the reſt, we muſt conſider whether it be an oriental or an occidental dial.

2 An oriental Dial looketh to the Eaſt, and the forenoone houres onely muſt bee ſet in this Dial, and therefore the ſubſtilar line ſheweth ſix of the clocke in the morning; from which towards the South are the morning houres before ſixe, *viz.* 5. 4. 3. &c. but towards the North after ſix, 7. 8. 9. 10. 11. as in the 3 figure.

3 An occidental Dial looketh directly Weſtwards: and onely the houres after noone can bee ſet into this dial. Therfore the ſubſtilar line ſheweth the ſixt houre after noone: from which toward the North are the houres before ſix in this order. 5. 4. 3. 2. 1. but towards the South after ſix thus. 7. 8. 9. &c. as in the 4. figure.

4 In Dials not Meridian, if a ruler laid to the center of the æquinoctial and the beginning of the diuiſion thereof doe croſſe the touchline; then the houre line drawne by that croſſing is the line of twelue a clocke. But if it cannot croſſe the touch line, imagine notwithſtanding, that croſſing and the twelue a clocke line, drawne thereby without the bounds of your Dial, whereabouts you thinke it would bee, if the ruler and touch line were

continued foorth long inough.

5 Then in al Dials not meridian, imagine the ſtile to be faſtned in his place, in æquinoctial Dials perpendicularly erected out of the Center. In Dials that be not Equinoctial, conceiue it to be placed exactly ouer the ſubſtilar line, ſo much raiſed from the ſame as the ſtilar line in your paper or paſtbord, is diſtant from the ſubſtilar line.

6 After this, place your paper or paſtebord (whereon the figure of your Dial is deſcribed) in the ſame ſite or poſition that the dial ground is, or muſt be placed; ſo that the quarters of the world written thereupon, may anſwer in like poſition to the quarters of the world as they lie in reſpect of your dial ground: for then if the 12. a clocke line be towards the North, from the ſtile it is the line of the 12. houre of the day. From hence therefore towards the Weſt are the forenoone houres, 11.10. 9.8.7. &c. and toward the Eaſt, the afternoone houres, 1.2.3.4.5.6. &c.

7 But if the 12. a clocke line bee Southward from the ſtile, it is the line of the twelfth houre in the night from thence: therefore on both ſides are the night houres: toward the Weſt, after midnight, 1.2.3.4. &c. towards the Eaſt before midnight, 11.10. 9. 8. &c.

Chap. XVI.

What houre lines are to be expreſſed in all ſorts of Dials.

IN al Dials, thoſe houre lines onely are to be expreſſed, vpon which the ſhadow of the ſtile ſhal fall. Therefore the houres of the day onely are to bee expreſſed.

2 In Dials not Polar, wherein the height of the ſtile is not augmented, if the ſtile point vpwards, and the eleuation thereof from the ſubſtilar line, bee not leſſe then the complement of the ſunnes greateſt declination, all the houre lines ſeruing for the longeſt day, are to be expreſſed therein.

3 But if the eleuation of the ſtile from the ſubſtilar be leſſe then the complement of the Sunnes greateſt declination, draw a right line out of the interſection of the line of contingence, and ſubſtilar perpendicularly ouerthwart the ſtilar line: and ſetting one foot of your compaſſes in the center of the dial, and extending the other towards the other end of the ſtilar line, draw an arke therefrom equal to the complement of the Sunnes greateſt declination: and thereby draw a line out of the center of the Dial, and ſetting one foot of your compaſſes in the interſection of this line with the foreſaid perpendicular, extend the other foot to the ſtilar line: Then keeping this diſtance, ſet one foote of your compaſſes in the center of the æquinoctial circle and with the other croſſe the line of contin-

gence on both sides the substilar: now if you lay your ruler to these crosses and the center of the Dial: right lines drawne thereby beyond the center of the Dial shal continue betweene them the space wherein no houre lines are to be expressed.

4 This rule holdeth also in meridional Dials inclining, when the elevation of the stile is counted from the vpper end of the Meridian line, and the elevation of the stile from the substilar is lesse then the complement of the Sunnes greatest declination.

5 If the stile point downwards, no houre lines are to be expressed aboue a line parallel to the horizon drawne by the center of the Dial.

6 And if the crosse in the line of contingence (made as before was shewed) be aboue the line æquidistant to the horizon, drawne by the center of the Dial; no houre lines are to be expressed aboue a right line drawne from the crosse and continued beyond the center of the Dial.

7 If any part of the Dial whereupon the shadow of the stile may fal, bee void of houre lines: let the houre lines before described bee continued foorth into that part of the Dial, as in the 13 and 15 figure.

Chap. XVII.

How to translate the Diall drawne on paper or pastebord vnto the Dial ground.

THe figure of your Dial being thus described, you shall translate the same into the Dial ground, after this manner.

2 Place the paper or pastebord whereas the figure of your dial is described in such sort, in the Dial ground is placed, so as the quarters of the world written on the paper or pastebord may answer in like position to the quarters of the world as they lye in respect of the Dial ground.

3 Then as the houre lines and substilar line are described in your pastebord, so in like manner, and in like position, let them be inscribed into your Dial ground that so little part of the ground as may be, be left voide of houre lines serving for vse, and that the spaces on both sides from the substilar line drawne on the Dial ground bee proportionable to the number of houre lines that are to bee expressed in the Dial.

4 In Polar dials draw a right line squire-wise ouerthwart the substilar in the Dial ground; then take with your compasses the distances of the houre lines from the substilar in the pastebord, and set them into that line drawne squire-wise in the Dial ground, setting alwaies on foot in the intersection thereof with the substilar line, and with the other foote making pricks in the said line drawne squire-

wise: And let paralels to the ſubſtiar line be drawn by thoſe prickes, for they ſhall bee the houre lines we ſeeke for, ſet into the dial ground.

5 The ſtile muſt be paralel to the ſubſtilar line, and muſt be placed directly ouer it, ſo much diſtant from the ſame, as the ſtilar line is diſtant from the ſubſtilar in the figure of your Dial drawne on the paſtbord or paper.

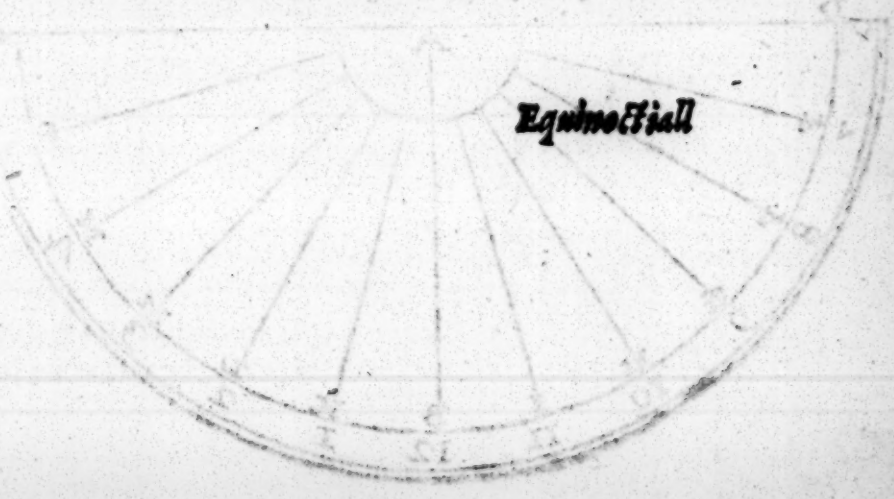
6 In Dials that be not polars, wherein the eleuation of the ſtile from the ſubſtilar is not augmented, deſcribe two peripheries of equal bigneſſe on the Dial ground, the center thereof being placed in the meridian line, the other vpon the center of the Dial in the baſtbord: then in this peripherie take the diſtances of the ſubſtilar and the houre lines from the Meridian with your compaſſes, out of the figure of your Dial in the paper or paſtbord, & ſet thoſe diſtāces likewiſe into the dial grounds, and by them draw the houre lines and the ſubſtilar from the center of the dial.

7 The ſtile muſt bee faſtned in the center, and muſt hang directly ouer the ſubſtilar, eleuated ſo much from the ſame, as the ſtilar line in the figure of your dial is diſtant from the ſubſtilar.

8 But in Dials that be not polars, wherein the eleuation of the ſtile from the ſubſtilar is augmented, let the ſubſtilar line bee deſcribed in the Dial ground ſo much diſtant from the Meridian, which you firſt deſcribed therein, as the ſubſtilar is diſtāt from the Meridian in the figure of your dial. And let two lines of contingence be drawne ſquire-

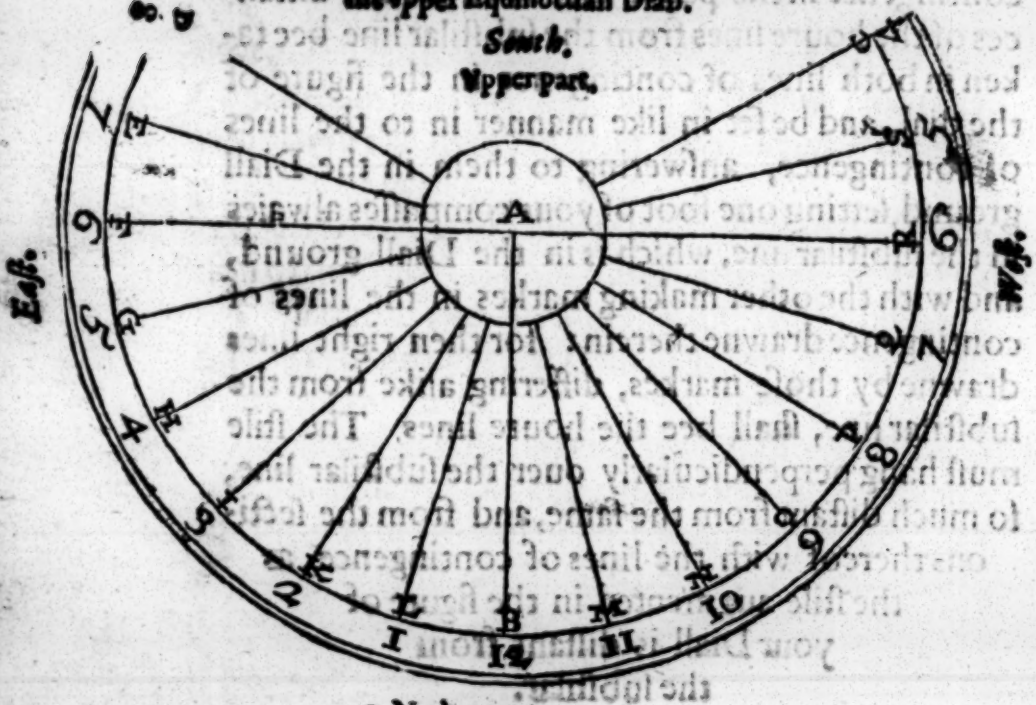
wiſe.

wiſe ouerthwart that ſubſtilar in the Dial ground, ſo much diſtant each from other, as the lines of contingence in the paper are. And let the diſtances of the houre lines from the ſubſtilar line bee taken in both lines of contingence in the figure of the dial, and be ſet in like manner in to the lines of contingence, anſwering to them in the Diall ground, ſetting one foot of your compaſſes alwaies in the ſubſtilar line, which is in the Diall ground, and with the other making markes in the lines of contingence drawne therein: for then right lines drawne by thoſe markes, differing alike from the ſubſtilar line, ſhall bee the houre lines. The ſtile muſt hang perpendicularly ouer the ſubſtilar line, ſo much diſtant from the ſame, and from the ſections thereof with the lines of contingence, as the ſtile augmented in the figure of your Diall is diſtant from the ſubſtilar.

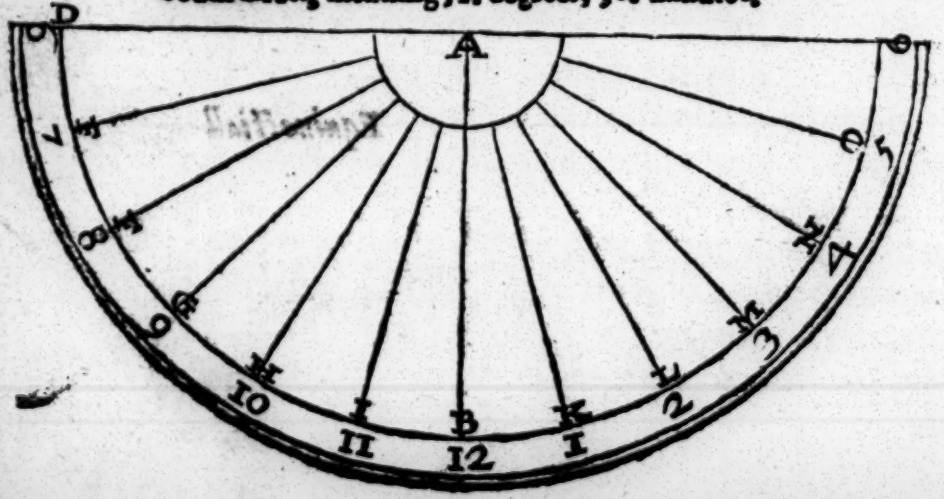


Equinoctiall Dials.

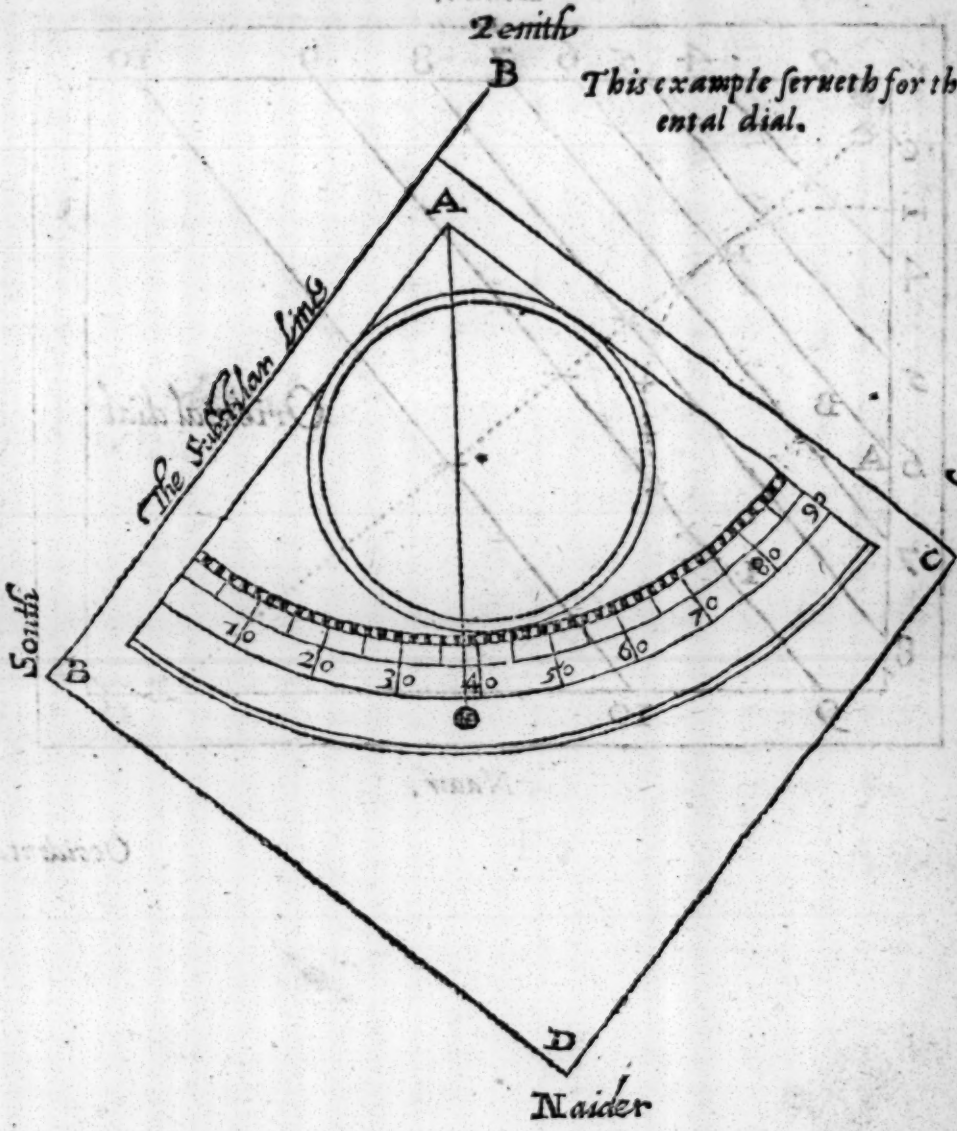
North direct reclining 51. degrees, 30. minutes, or the vpper Equinoctiall Dial.



South direct, inclining 51. degrees, 30. minutes.

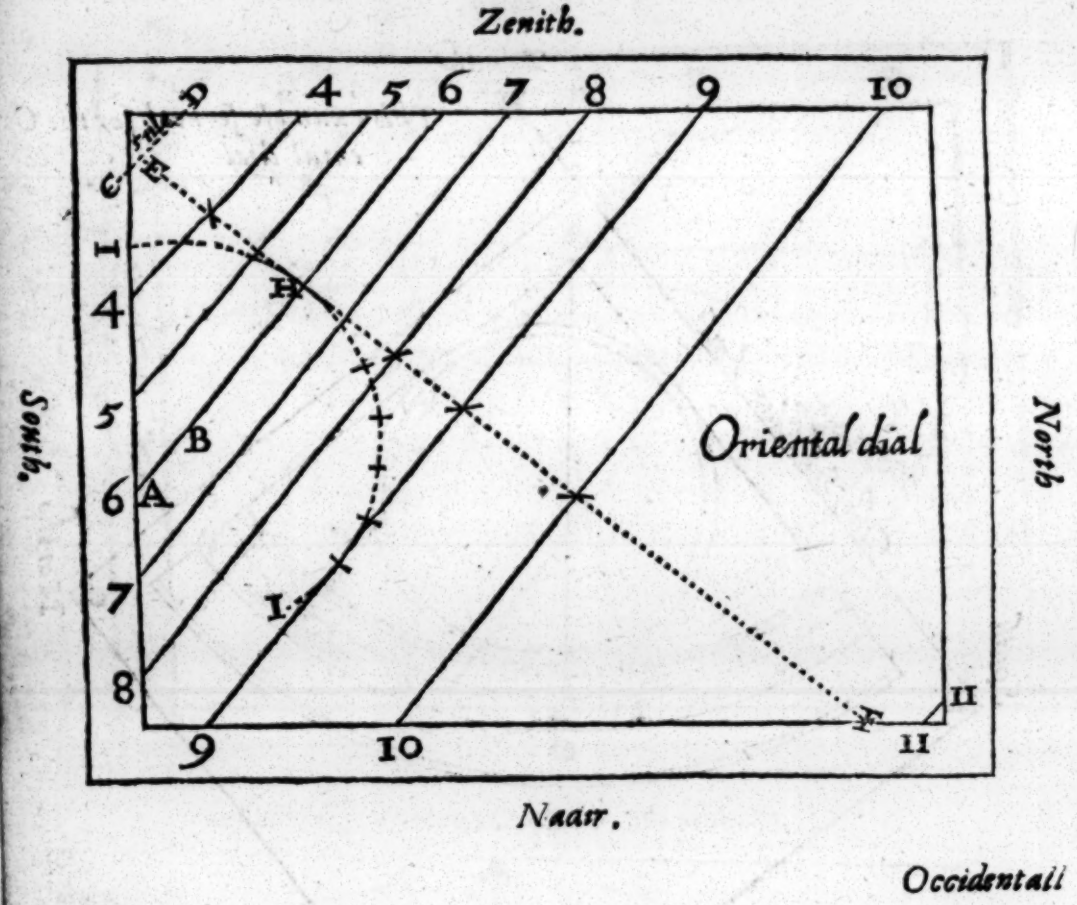


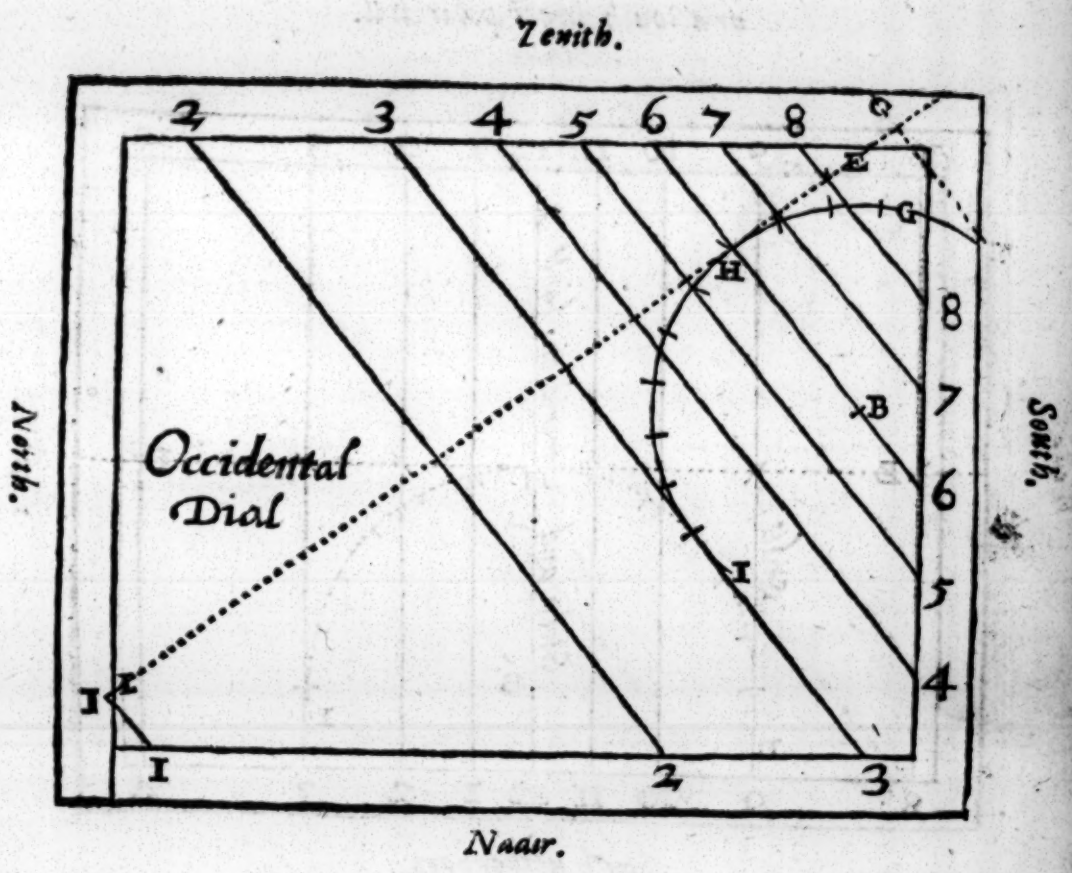
The manner of finding the ſubſtilar line in Meridian *Polar Dials.*



F Meridian

Meridian Polar dials.




Zenith.
2
3
4
5
6
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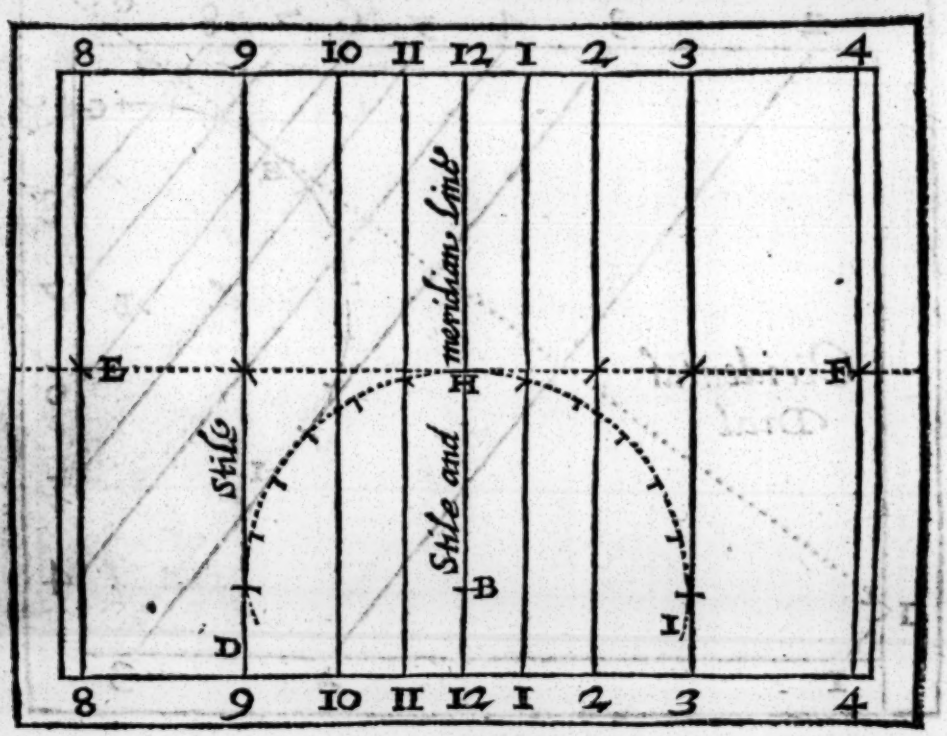
8
G
E
G
H
8
B
7
6
5
4
I
North.
Occidental Dial
South.
I
I
2
3
Naar.

A South direct dial reclining 38 degrees 30. minutes,

or a South direct polar dial.

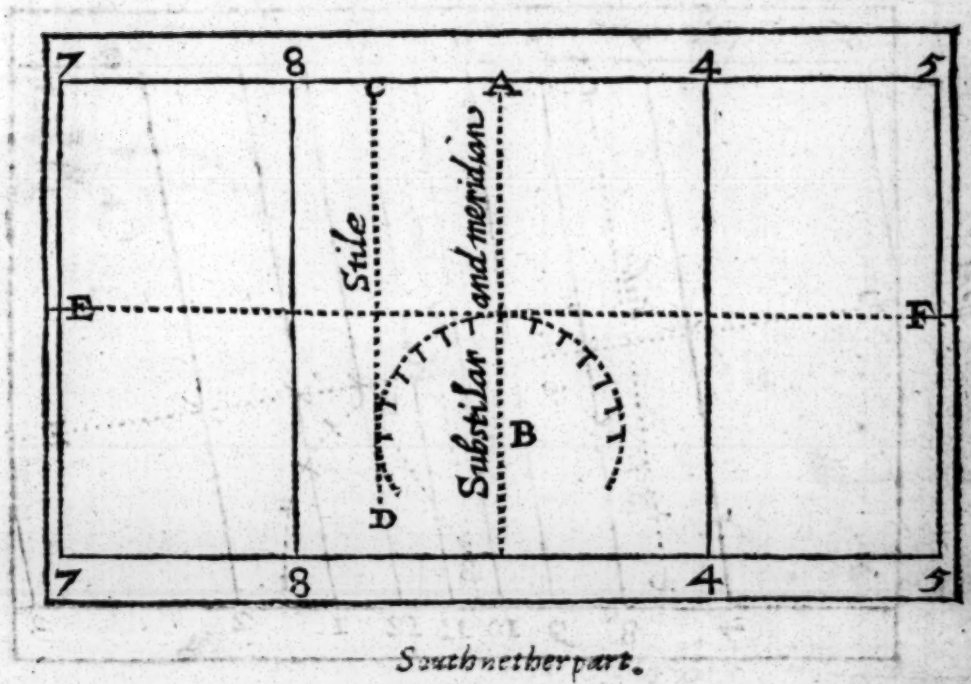


South, nether part.

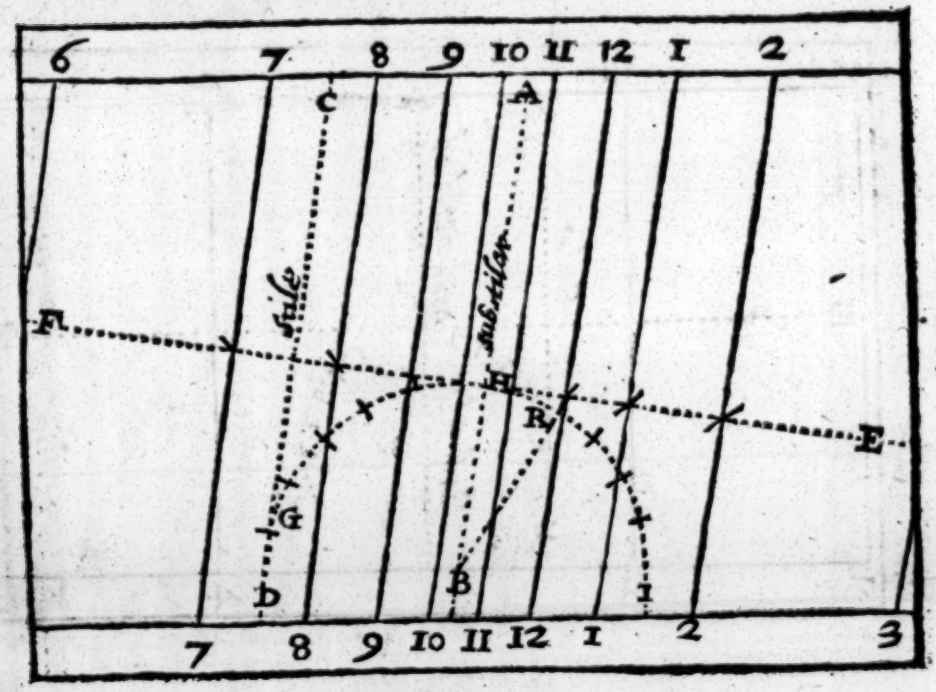
A North

A North direct dial inclining 38 degrees 30. minutes.

or a North direct polar dial.



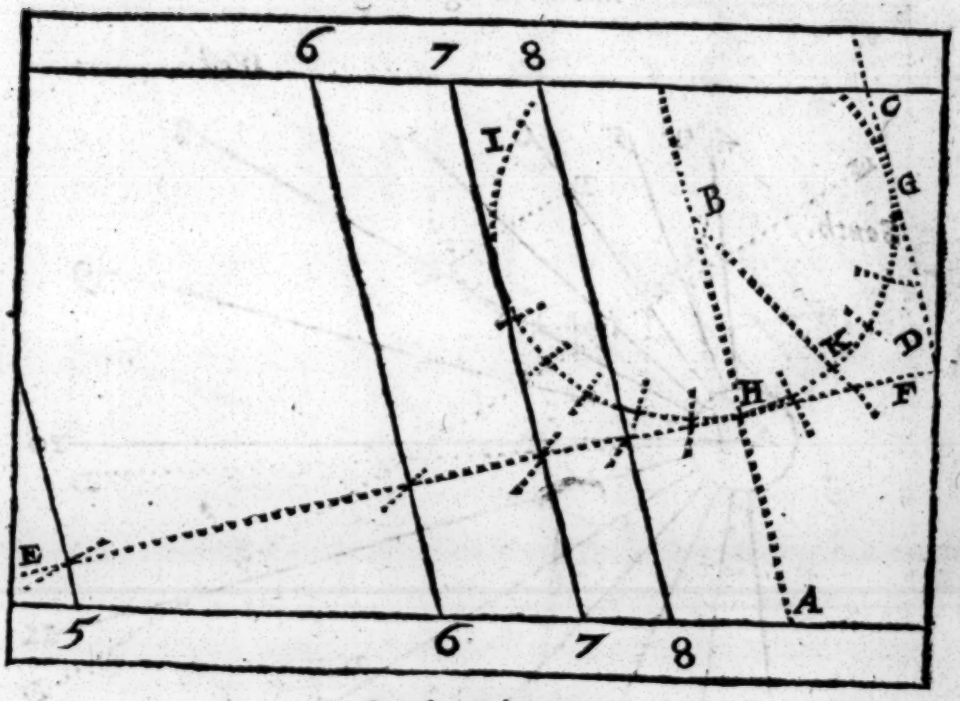
South declining Eastward 27. degrees, reclining 34. *degrees* 40. *minutes.*



South nether part.

North

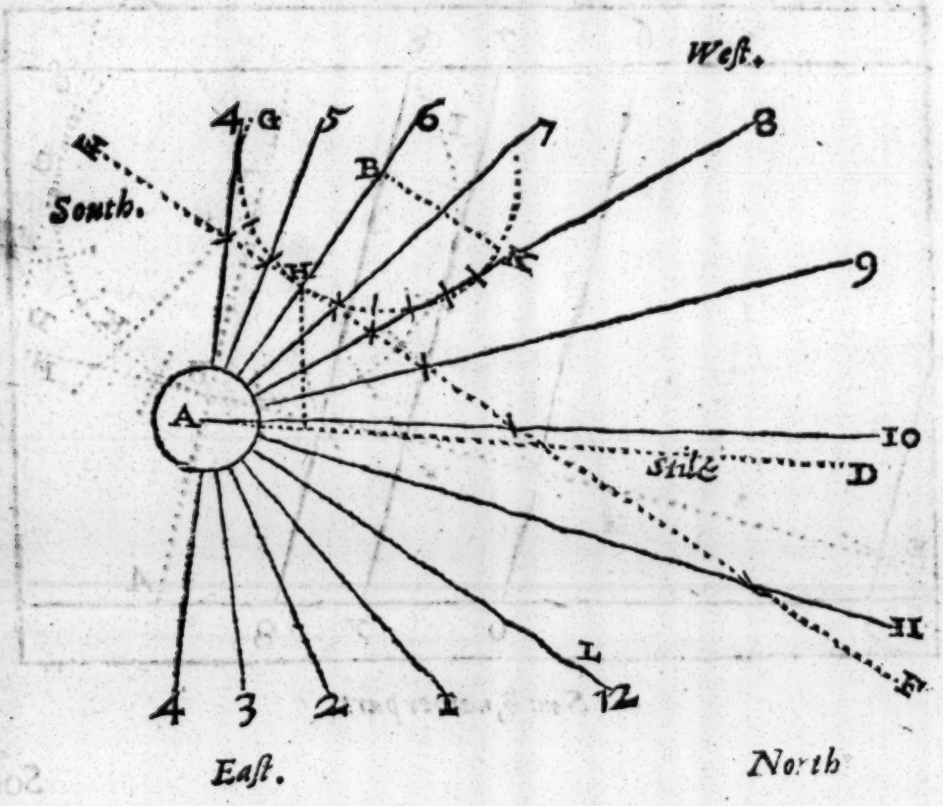
North declining Westward 36 degrees inclining 32. *degrees* 15 *minutes.*



South, nether part.

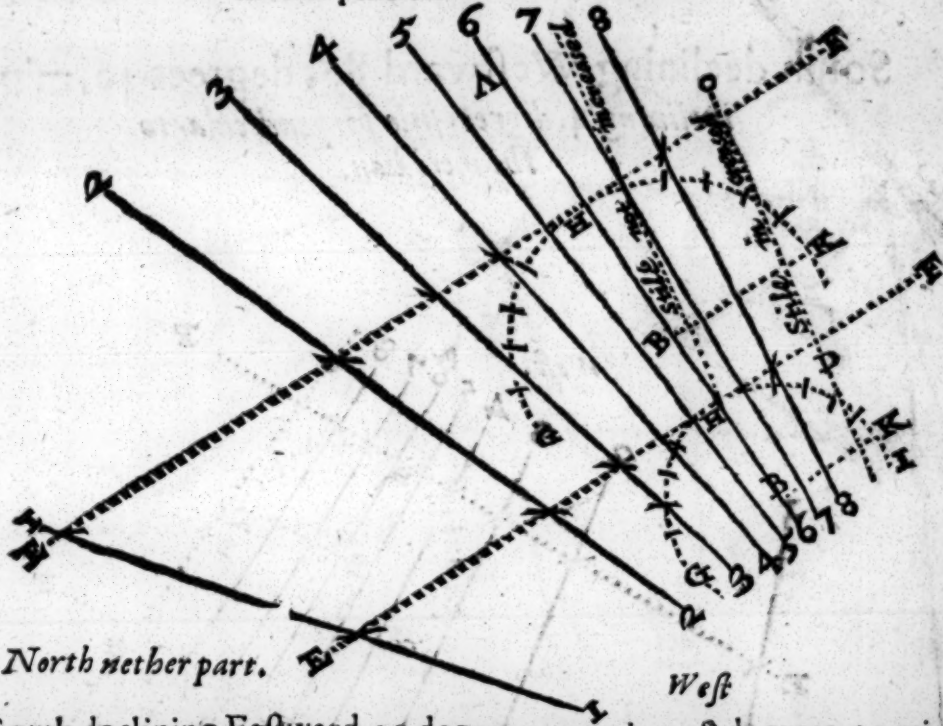
South

North declining Eaſtward 43. degrees reclining 42. *degrees* 20. *minutes wherein the ſtile and meridian line make right angles.*

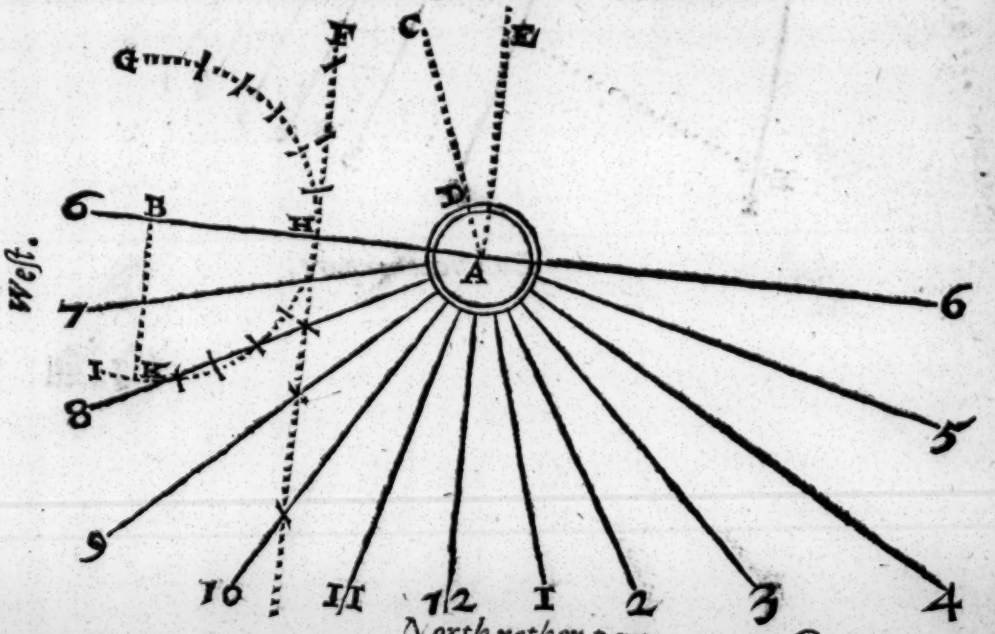


North

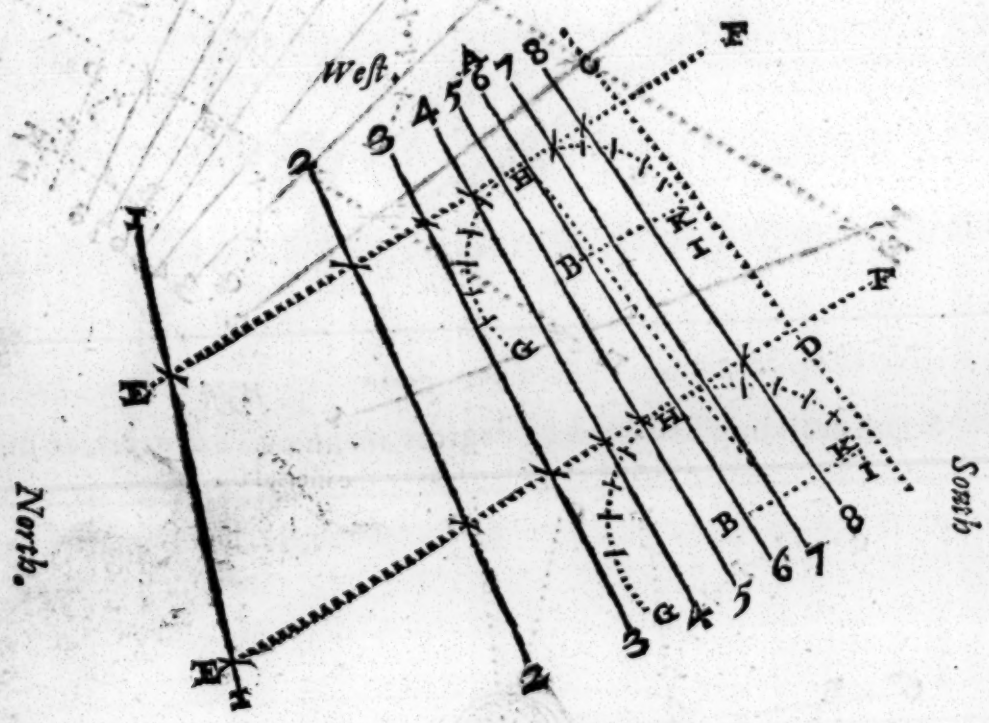
North declining 84 degrees westward, reclining 7 degrees 20 minutes, the ſtile pendicular to the Meridian line.



South declining Eaſtward 31 degrees, inclining 48 degrees. 20 min. the ſtile perpendicular to the meridian.

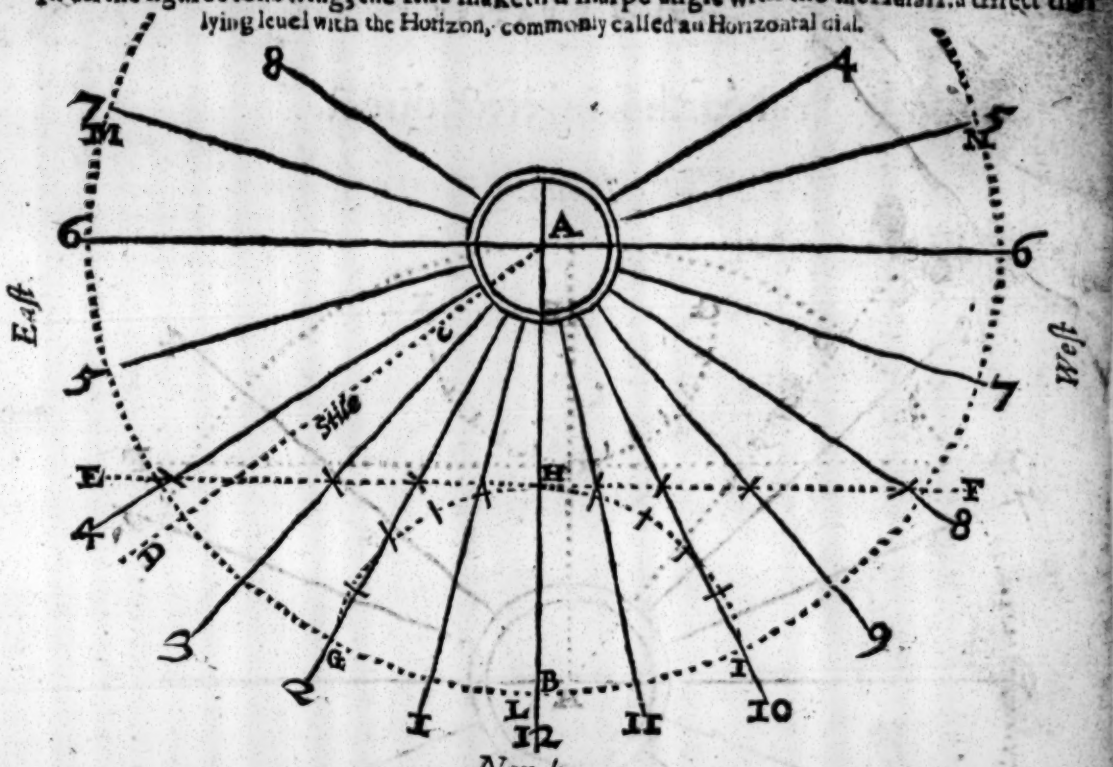


South declining Westward 86. degrees 40. min.
inclining 4. degrees stile perpendicular to the meridian.

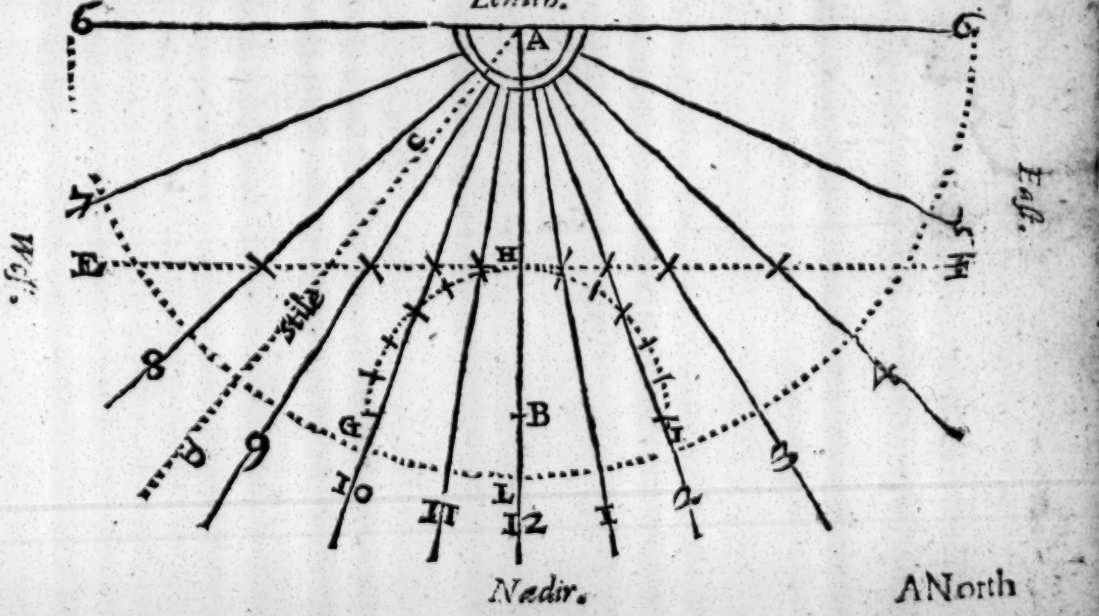


In all

In all the figures following, the ſtile maketh a ſharpe angle with the meridian: a direct dial lying leuel with the Horizon, commonly called an Horizontal dial.

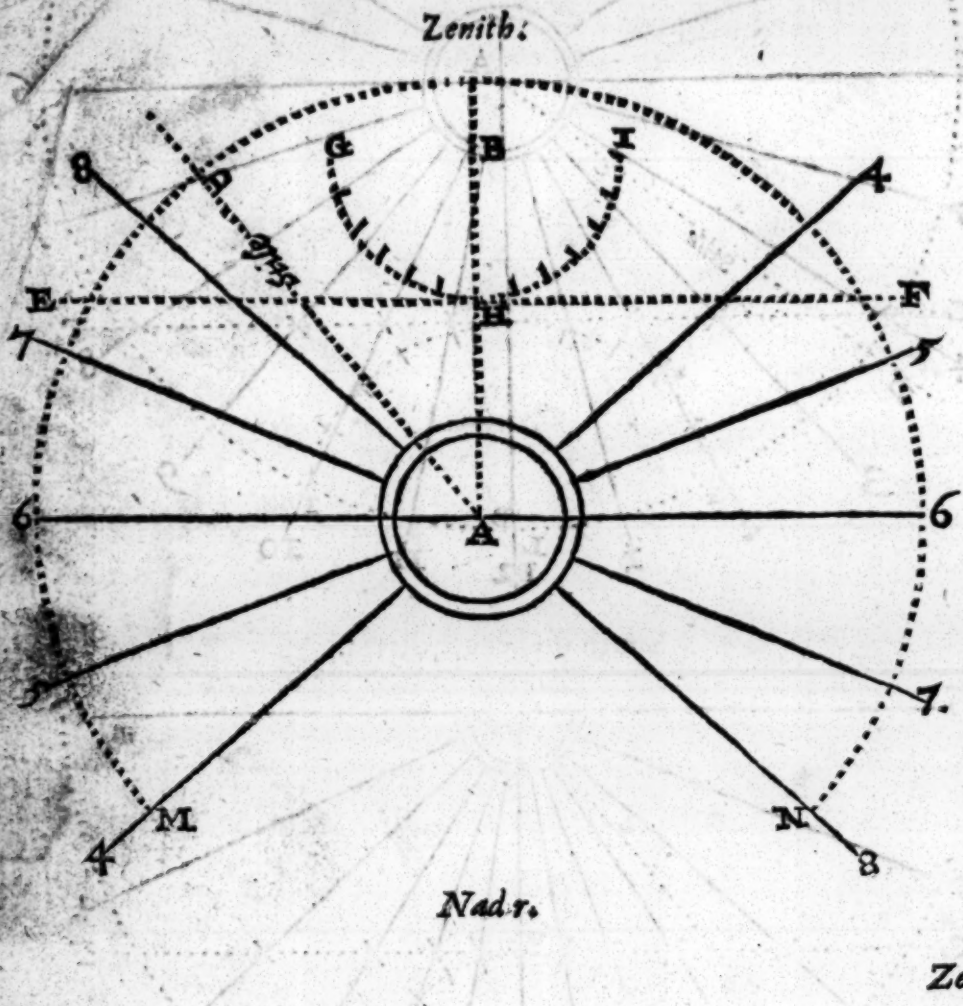


A South dial erect direct.

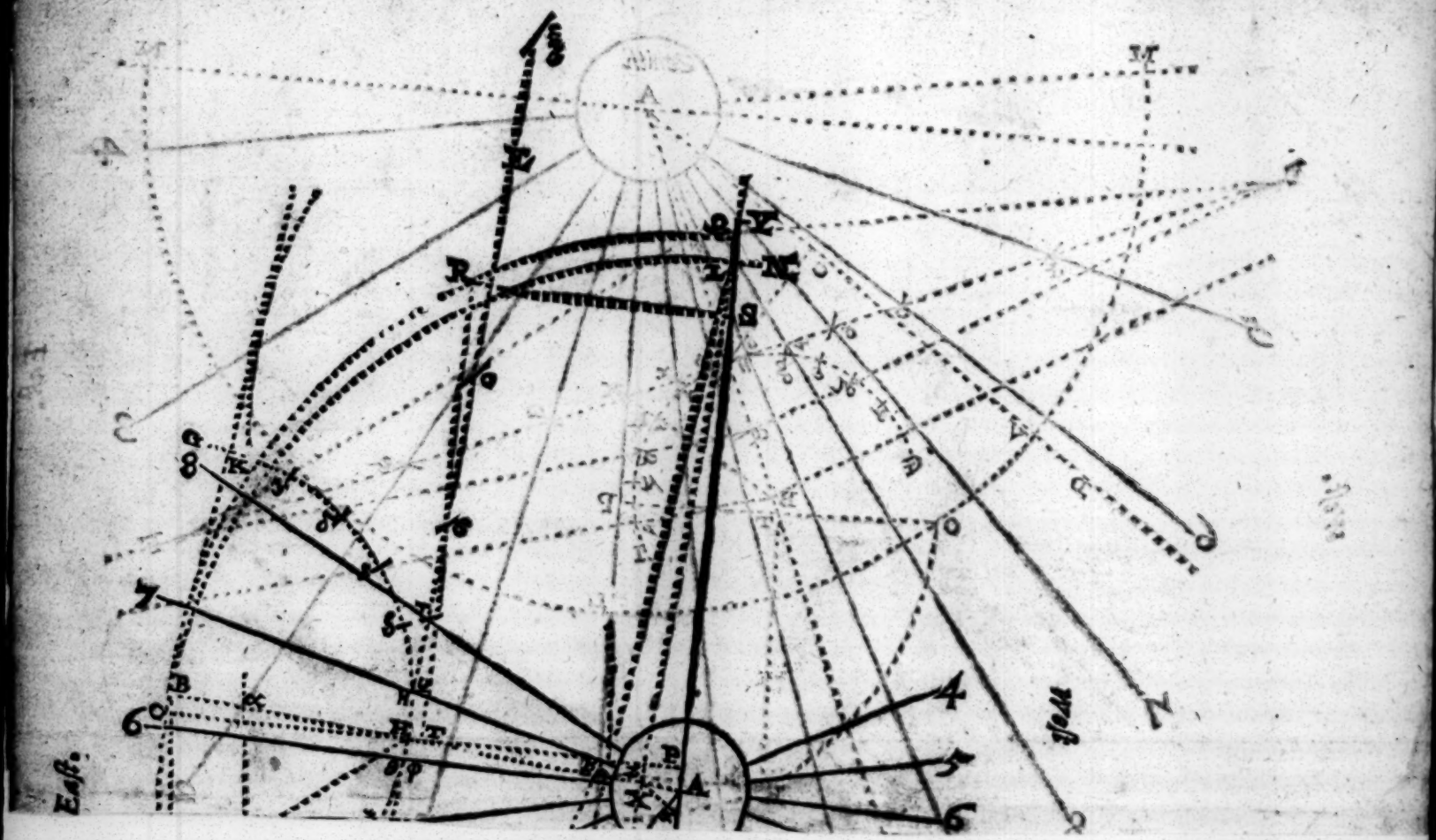


ANorth

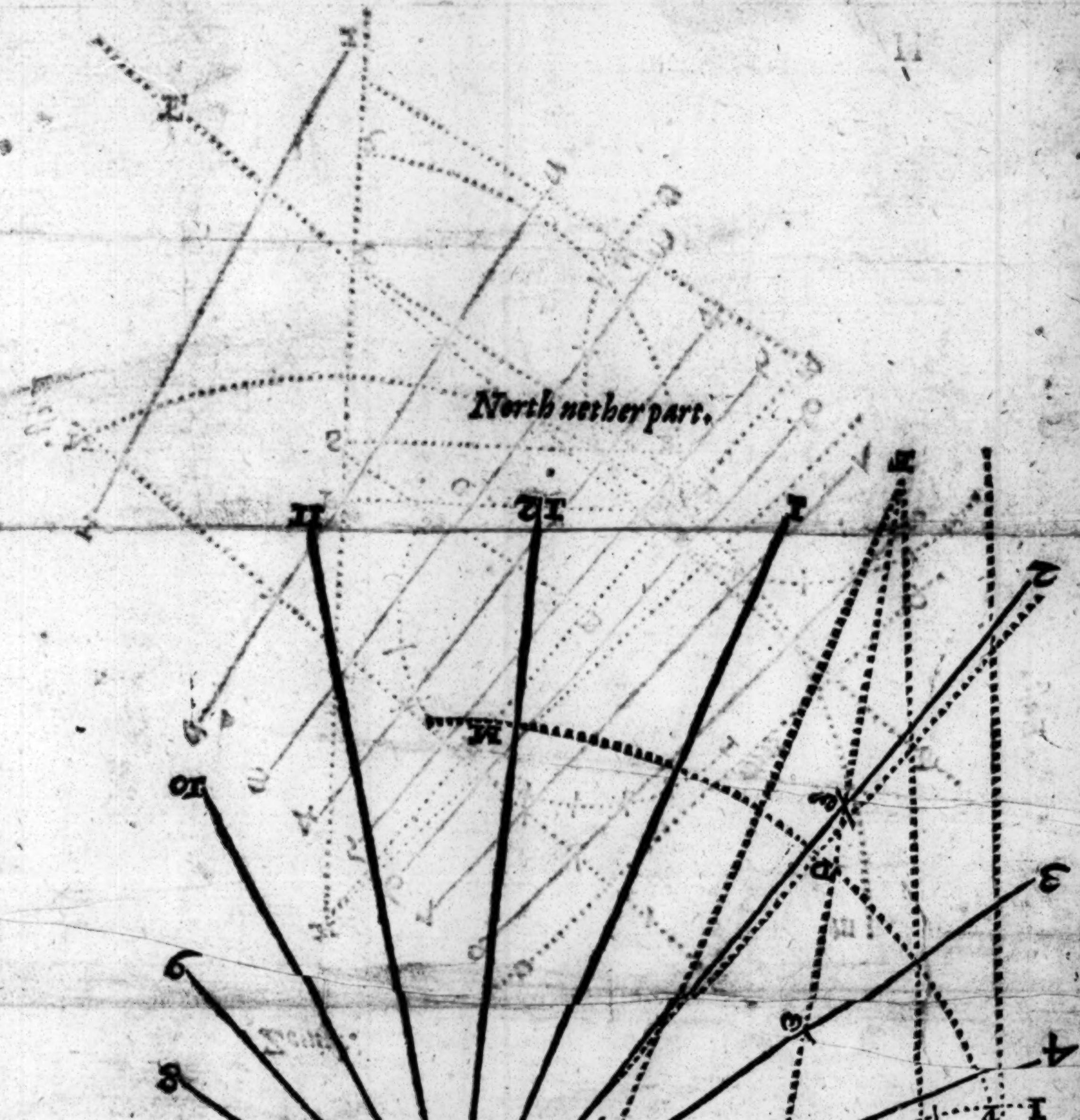
A North Dial erect, direct.



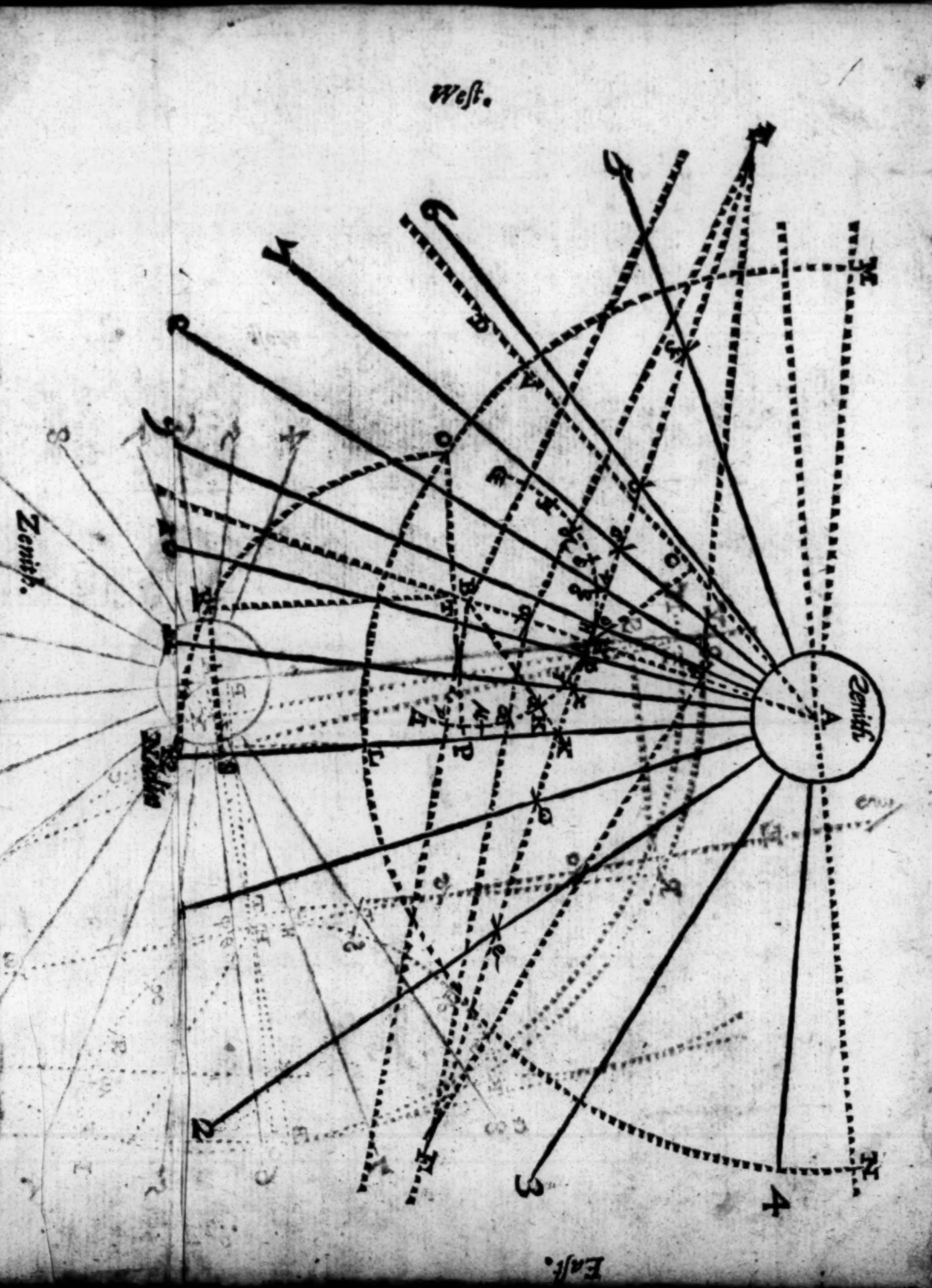
South upper part.



West.
South upper part.
East.


North nether part.

West.
Zenith.
Nadir.
East.



West.
Zenith
Zenith.
East.

Zenith
M
N
E
W
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2
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6
7
8
9
10
11
12

$A^2(-A^{-2}) B - F^4 G^2 + H$ (folds sheet)